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IRRIGATION IN A·L·B·E·R·T·A

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Print Media Branch
Alberta Agriculture
7000 - 113 Street
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IRRIGATION IN ALBERTA

The development of irrigated land in Western Canada has progressed for more than 75 years. Water resources have been partially developed, and the engineering problems associated with water storage, diversion, and delivery to the farm are well understood. Procedures for handling water on the farm are still being developed and irrigation methods are being improved. This bulletin outlines the history of irrigation and discusses some of the unresolved problems.

HISTORY OF IRRIGATION IN ALBERTA

Water for Alberta's first irrigation scheme was diverted from Fish Creek, now at the southern edge of the City of Calgary, in 1897.

Further development centred south and east of Calgary and falls into four phases.

- company (or private development) phase (1890 — 1915)
- irrigation district (or co-operative) phase (1915 — 1940)
- government phase (1940 — 1969)
- cost-sharing phase (1969 — present)

As compensation for their effort in establishing railways across Canada, the development companies (Canadian Pacific Railway, Alberta Railway and Navigation Company) obtained large blocks of land in southern Alberta from the Canadian government. The companies turned to irrigation development as the best means of paying for the railways and colonizing the land. During this, the company phase, four major areas were constructed and introduced to irrigation.

In the late 1890s, Alexander T. Galt and his son Elliot T. Galt, with the assistance of the Mormon Church, diverted water from the St. Mary River at Kimball (southeast of Cardston) and through a series of constructed and natural channels, brought this water to the areas of Magrath, Raymond and Lethbridge. The first water was turned out through the Kimball headgates on July 4, 1900 and reached Lethbridge at the end of that same month.

In 1903, the Canadian Pacific Railway began construction of an irrigation system east of Calgary, with a diversion weir on the Bow River at Calgary and a canal and lateral system in the Strathmore area, known at the time as the Western Block. With this project about 200,000 acres were envisioned as being under irrigation.

In 1909, the CPR began construction of an irrigation system in the Brooks area consisting of a diversion structure on the Bow River near Bassano, and an extensive canal and lateral system between the Bow and Red Deer rivers. The area was known as the Eastern Block and development of about 400,000 acres of irrigation was anticipated.

In 1909 an English firm called the Southern Alberta Land Company, along with some smaller companies, started an irrigation system by diverting water from the Bow River, near Carsland, to irrigate a large block of land in the Vauxhall area with the intention of making a profit from the sale of irrigable land. This venture anticipated the development of approximately 240,000 acres of irrigated land. The companies eventually merged to form the Canada Land and Irrigation Company. (See map in centre spread).

All of these projects suffered from financial difficulties in various degrees, and none of them, to date, has fully achieved its projected development.

In 1915, just ten years after it had become a province in the Dominion of Canada, the Government of Alberta enacted The Irrigation Districts Act. The legislation set the stage for the "district" (or co-operative) phase of irrigation development. This permitted the farmers of an area to organize for the purpose of floating a bond issue to raise funds to construct an irrigation project. The following areas were organized and constructed under the act.

- Taber Irrigation District — 1919 operational 1921
- Lethbridge Northern Irrigation District — 1919 operational 1923
- United Irrigation District — 1921
- Mountain View Irrigation District — 1921
- Magrath Irrigation District — 1925 - originally part of St. Mary project, operational in 1900
- Raymond Irrigation District — 1926 - originally part of St. Mary project operational in 1900
- Leavitt Irrigation District — 1936 - received assistance from federal government on diversion works and storage reservoir
- Eastern Irrigation District — 1935 - originally the Eastern Block of CPR and operational in 1912
- Western Irrigation District — 1944 - originally the Western Block of CPR and operational in 1905.

The Eastern Block of the CPR project was taken over by farmers in 1935, and was organized into the Eastern Irrigation District also under The Irrigation Districts Act. The transaction included all assets and rights-of-way, a block of land comprising 600,000 acres plus a cash amount of $300,000. Approximately 235,000 acres are presently on the assessment rolls of this district.

The Western Block of the CPR project was taken over by the farmers of the area and was organized into the Western Irrigation District (under The Irrigation Districts Act) in 1944. It acquired all assets and rights-of-way and a cash amount of $400,000. About 80,000 acres are presently on the assessment rolls of the district.

The St. Mary project was taken over by the provincial government in 1946 and later became an irrigation district with the enactment of The Irrigation Act in 1968.

In 1935 the federal government organized the Prairie Farm Rehabilitation Administration (PFRA) to provide engineering and financial assistance on water development projects on the prairies, thus initiating the government phase of irrigation development. One of its first projects in Alberta was the development of a storage, diversion and main canal to supply water to the

Aetna Irrigation District in 1945. This development also ensured a better water supply to Mountain View Irrigation District and the Leavitt Irrigation District.

The federal and provincial government works consisted of a massive system of reservoirs and canals to ensure water supply to the Magrath, Raymond and Taber Irrigation District and the CPR project in the Lethbridge-Coaldale areas, as well as the expansion of irrigation from Taber to Medicine Hat. Among these works were:

- St. Mary Reservoir
- Milk River Ridge Reservoir
- Jensen Reservoir
- Chin Reservoir
- Waterton Reservoir
- Belly River Diversion
- Main canal network connecting all these reservoirs
- Main canals and distribution canals to permit approximately 180,000 acres of irrigation from Taber to Medicine Hat.

The cost of these works was shared between Canada and Alberta, with Canada providing all the engineering, the capital expenditure on the Waterton, Belly, St. Mary, and Ridge Reservoirs and the connecting main canals. Alberta provided the financing for all of the works beyond Ridge Reservoir to Medicine Hat.

The government of Canada bought out the Canada Land and Irrigation Company in 1950 and began rebuilding the works of that area including additional storage in Traverse Reservoir, enlargement of Lake McGregor Reservoir, enlargement of the main canal from the Bow River near Carsland to the end of the present project near Hays, and development of a major lateral distribution system in the Hays area. Alberta became involved in the project with construction of a major lateral distribution system in the Enchant, Traverse, and Lamond areas.

By the early 1960s, the works of the older irrigation systems were nearly 60 years old, and the structures were in a state of extreme deterioration. Replacement funds were not available to take care of this work. Representation was made to senior governments for assistance, and as a result a joint irrigation study was completed in 1967, the purpose of which was to identify the beneficiaries of irrigation.

The major recommendation of this study was that the cost of rehabilitation of the irrigation systems should be shared among the two senior governments, the local municipality, and the irrigation farmers. A new irrigation act was passed in 1968 which put the administration of all irrigation under one piece of legislation, introducing the "cost sharing" phase of irrigation. The major undertakings in the first few years of this phase were the rehabilitation of the older systems, and the provision of extensive seepage control on district canals.

Under the terms of a 1973 agreement between Canada and Alberta, Alberta took over the operation of all on-stream diversion works operated up to that time by Canada, as well as the Bow River project in the Hays and Vauxhall areas. Subsequently, Alberta established a policy of assuming basic responsibility for water supplies to all users, including operation of on-stream diversion works and major reservoirs.

Present Status of Irrigation Development

In 1983, 1,109,329 acres in Alberta were serviced by the following irrigation districts:

Aetna	2,916
Bow River	181,174
Eastern	244,099
Leavitt	4,440
Lethbridge Northern	116,745
Magrath	12,257
Mountain View	3,710
Raymond	39,148
Ross Creek	1,776
St. Mary River	313,728
Taber	72,623
United	33,448
Western	83,265

Irrigation Rehabilitation

The majority of canals and laterals located within the irrigation districts, which were constructed between 1920 - 1955, are in various stages of disrepair. At the time of construction, the best available information was used in construction of these canals and laterals. But in looking back, it is evident technology was limited and construction standards were generally poor. Concrete structures were often not reinforced. Small structures were built of untreated lumber. Canals and laterals were built of earth on the contour, at or above ground level, and were unlined. With time, seepage from canals has caused many acres of land to become unproductive, either because of salinization or waterlogging. Canals have eroded and many structures have failed or washed out over the years. Without major technical assistance and aid, it is estimated that by the end of this century, most irrigation distribution systems would be degraded to such an extent that their use would be limited, and the irrigation farmers would be forced back to dryland farming.

In 1969 a funding program was announced to help irrigation districts rehabilitate and expand the irrigation distribution systems. The objectives of this program are to maintain a secure water supply, conserve land and water, improve the operating efficiency and effectiveness of existing irrigation systems, and to expand irrigated agriculture through intensification, extension and expansion of irrigation projects. The costs are shared with the province paying 86 per cent and the irrigation district (the irrigation farmers) paying 14 per cent. The funds are distributed between districts according to the ratio of each district's revenue and acreage as compared to the total revenue and acreage for all districts. Some funds are spent on major works (large canals and reservoirs) of the district, and the rest on smaller canals and laterals. Since the program's inception, $171 million has been spent. The program is expected to last into the mid 1990s.

Crop Production 1983

Acreages of crops grown on this irrigated land were as follows:

CROPS	ACREAGE (ACRES)	CROPS	ACREAGE (ACRES)
Wheat SW Other	21,000	Potatoes	13,400
Soft Wheat	446,000	Sugar Beets	32,200
Oats	11,000	Hay	159,500
Barley	111,000	Beans	3,600
Flax	5,100	Greenfeed	9,300
Oilseeds	15,400	Corn Silage	7,500
Peas	11,800	Hay Silage	7,500
Mixed Grains	2,000	Alfalfa Seed	11,000
Silage Corn	18,000	Canola	44,000
Corn	12,000	Mustard	2,100
Canning Corn	3,000	TOTALS	946,400

IRRIGATED SOILS OF ALBERTA

The soils in the irrigated areas in Alberta, with the exception of those in river valleys, are of glacial origin. As approximately 80 per cent of glacial till is derived from local bedrock, and as the material has had a lateral movement of less than two miles, the soils in any particular area have a very direct relationship to the underlying bedrock. Soils in the Lethbridge, Medicine Hat, Strathmore and Taber areas were formed on fresh-water deposits, and as a result are normal soils.

Most soils of the Eastern Irrigation District and some parts of the Bow River Irrigation District were formed on saline marine deposits. As a result these soils have a higher soluble salt content and are problem soils.

Tills are deposited in three distinct ways. End moraine tills are associated generally with rolling topography and non-arable lands utilized for grazing. Disintegration moraines are generally arable and can be irrigated by sprinkler methods. Ground moraines are of gently undulating topography usually well-suited to any method of irrigation. In general, all tills are moderately to fine textured, with fair water intake rates at the surface and slower water movement in the lower root zones.

Lacustrine soils originate from lake water deposits that generally have a fine texture and smooth topography. The fine texture of these soils restricts water movement therefore slow water application rates are required for successful irrigation.

Wind deposited soils are of coarser texture and vary from coarse sands to fine sandy loams. If sufficiently deep with textures tending toward loams, these are excellent irrigation soils. Water intake rates are high enough to permit rapid irrigation and drainage and they are especially well suited to specialty crop production. Restricted water holding capacity and susceptibility to wind erosion are the major limitations for coarse textured soils.

Alberta irrigated soils or potentially irrigable soils are classified according to their suitability for irrigation. The classification system is based on land topography, soil profile characteristics, soil texture, water holding capacity, drainability characteristics and depth and kind of subsurface material.

The presence of soluble salts or sodium and the movement of water through the soil profile are important considerations.

The classification system is designed to rate soils as to their suitability for long-term irrigation and it identifies soils which are not suitable.

Salts are present in all soils in the irrigated areas, with the possible exception of recent alluvial deposits in river valleys. Excess salts are harmful to plant growth in that they make it very difficult for plants to extract water and plant nutrients from the soil solution. This restricts plant growth. Very high salt concentrations may be toxic to some plants. If irrigation practices are such that the water table does not remain too close to the surface and there is a net downward flow of water through the soil profile, salinization will not occur.

In summary, a good irrigation soil is one with an adequate water holding capacity balanced with a suitable water intake rate. This usually implies a loam texture. A good irrigation soil is also well-drained, low in salts and has sufficient fertility to support an abundant plant growth.

Drainage

There exists a sensitive (or critical) soil-water balance within the soils of southern Alberta. The cultivation of large tracts of land over the past 50 to 100 years has resulted in a serious disturbance to this balance and has led to increasing dryland salinity problems. With the application of irrigation water, maintenance of the soil-water balance becomes even more difficult, particularly when excess water from canal seepage and over irrigation enters the soil. In the irrigated areas of Alberta, canal seepage, groundwater discharge and over-irrigation have resulted in severe problems occurring in many areas. Of the 1.0 million acres of land currently irrigated in organized districts, between 10 to 30 per cent are estimated to be adversely affected by waterlogging or soil salinity, with most problems directly or indirectly attributable to canal seepage.

Control and Reclamation

Reclamation of saline soils can only be successful after the water table in the problem area is lowered. This can be accomplished in two ways — by intercepting the excess water at its source, or by reducing the water

table in the problem area. Since canal seepage is the main cause of the excess water problems within the organized irrigation districts, large scale programs involving canal lining and interceptor drainage have been employed to prevent canal seepage. While effective, these measures are very expensive and not practical for the individual farmer to utilize in reclaiming his saline and waterlogged lands. Installation of shallow subsurface ($<$ 1.8 m below ground surface) drains throughout the problem area has proven effective in controlling the water table and promoting leaching of excess salts through the soil profile. Compared with canal lining and interceptor drainage, shallow subsurface drains are relatively inexpensive and have been increasingly utilized by individual farmers over the past seven to eight years.

With increasing land prices and intensified irrigation, on-farm subsurface drainage is expected to increase in the next decade. Farmers interested in having subsurface drainage systems installed are encouraged to contact their local irrigation specialist for advice and assistance with the planning and development of their drainage systems.

The Decision to Irrigate

The decision to proceed with farm irrigation development must be economically sound. Because drought is the limiting factor in crop production for almost all of the southern region of Western Canada, it is often assumed that irrigation will result in high yields. In order to reap the benefits from irrigation development, one needs to understand the changes in management that are required. Failure to understand these changes in management can result in economic disaster. Irrigated soils require special management techniques, land preparation, and drainage in order to produce high crop yields.

The map shows the average precipitation to be expected during the growing season in Alberta.

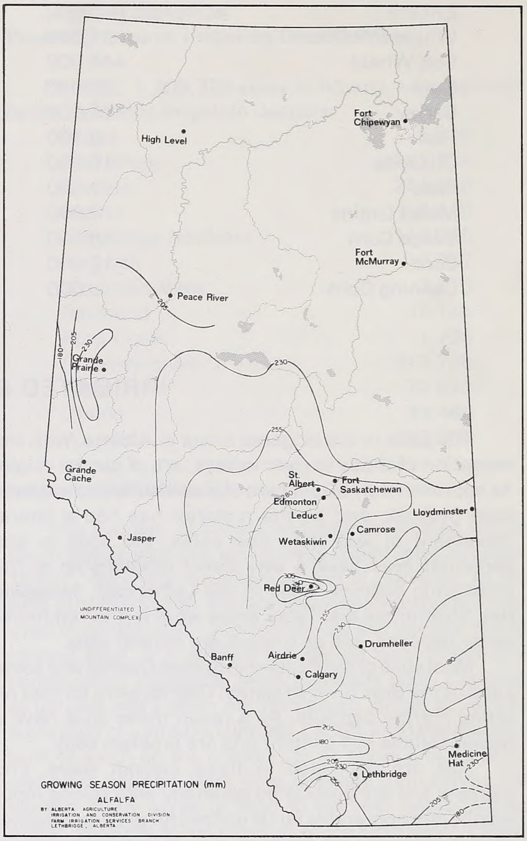
The graphs indicate the yield of various crops which can be expected from specified quantities of moisture, provided fertility is adequate. For a specific area, one can determine the expected yield from rainfall only, or calculate the extra water required from irrigation to obtain maximum yields (page 5).

The increased yield expected from irrigation can be reasonably predicted from the graphs. The actual increase in cost of production is dependent on such factors as soil type, land preparation, water source, drainage requirements and efficiency of management.

Water and Fertilizer

Water by itself or fertilizer by itself does not produce a crop. Limiting the amount of either water or fertilizer applied to the land limits the amount of crop that can be grown. In order to optimize crop production, the amount of water applied and the timing of this water is critical.

Although many Alberta soils require little or no fertilizer to produce under dry farming conditions, where available moisture is greatly increased by irrigation, there may not be sufficient plant food to produce the expected high yields, making the use of fertilizer a necessity.



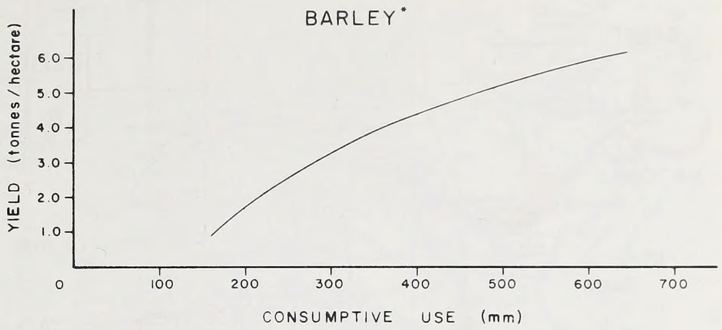
Irrigation Methods

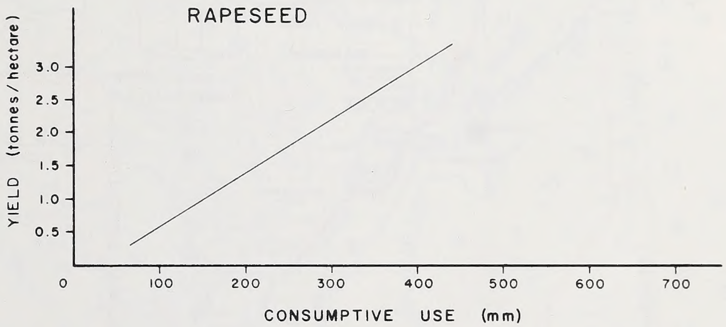
At the present time, the three principal methods used for applying irrigation water are surface, sprinkler and trickle.

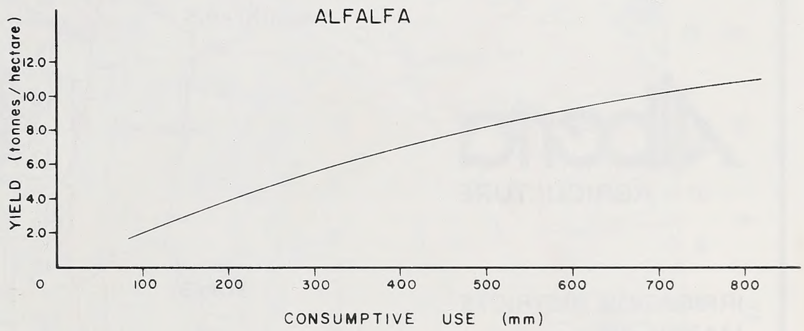
With the **surface method**, water is applied to the soil at the ground level. It flows by gravity over the surface of the field. For **close growing crops** such as grain and grass, water is spread over the soil surface by using (a) border dikes, (b) border ditches, (c) contour ditches or (d) corrugations.

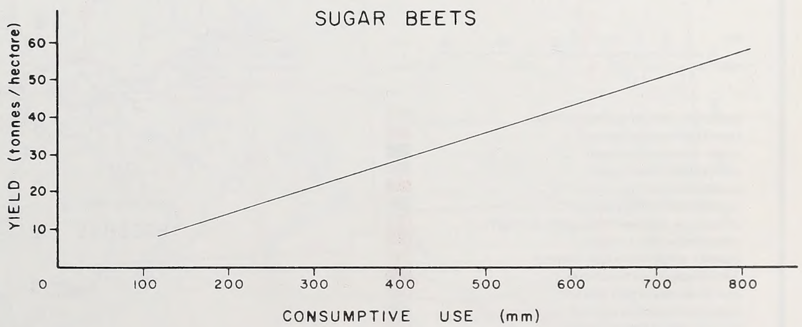
"Trickle" or **"drip"** irrigation uses a system of plastic pipes to convey the water across the ground. The water is directed to the soil surface by drippers spaced close together on the pipe. It is designed to operate nearly every day. The "trickle" system is generally costly to install, but gives very good results, particularly on greenhouse and vegetable crops.

With the **sprinkler method**, the water is sprayed into the air and falls to the ground like rain. This is usually accomplished by using rotating impact sprinklers or spray heads. There are many kinds of manual, semi-automated sprinkler systems available for use in Alberta, and the particular kind chosen will depend on many factors.



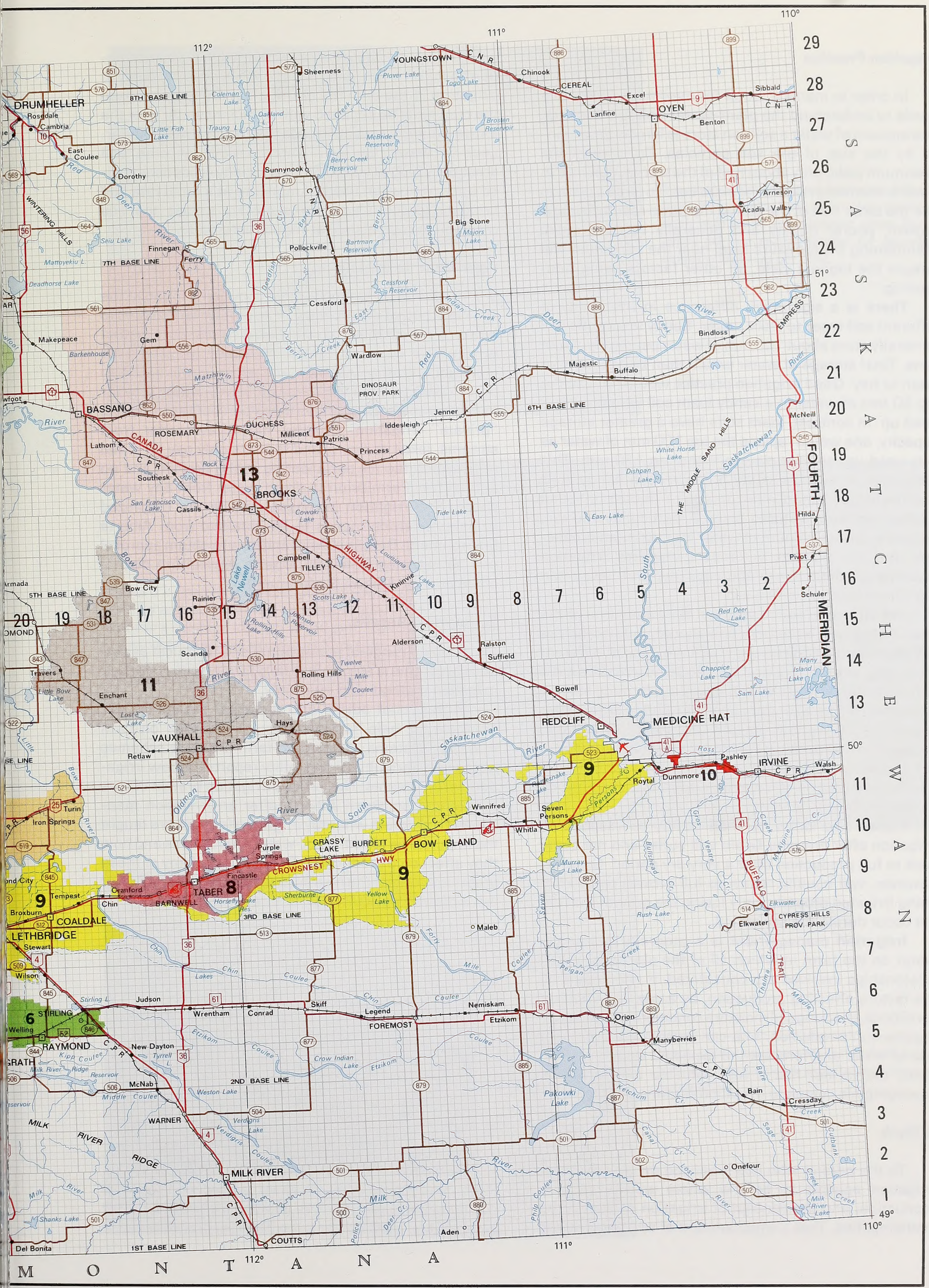






*CONSUMPTIVE USE IS THE AMOUNT OF MOISTURE USED ANNUALLY BY PLANTS.


Alberta
AGRICULTURE
IRRIGATION DISTRICTS
MARCH 1983
km 10 0 10 20 30 km
miles 10 0 10 20 miles
MOUNTAIN VIEW IRRIGATION DISTRICT 1
LEAVITT IRRIGATION DISTRICT 2
AETNA IRRIGATION DISTRICT 3
UNITED IRRIGATION DISTRICT 4
MAGRATH IRRIGATION DISTRICT 5
RAYMOND IRRIGATION DISTRICT 6
LETHBRIDGE NORTHERN IRRIGATION DISTRICT 7
TABER IRRIGATION DISTRICT 8
ST.MARY RIVER IRRIGATION DISTRICT 9
ROSS CREEK IRRIGATION DISTRICT 10
BOW RIVER IRRIGATION DISTRICT 11
WESTERN IRRIGATION DISTRICT 12
EASTERN IRRIGATION DISTRICT 13
PRODUCED BY THE ALBERTA BUREAU OF SURVEYING AND MAPPING © 1983
BANFF NATIONAL PARK
ROCKY MOUNTAINS FOREST RESERVE
BRITISH COLUMBIA
FIFTH MERIDIAN
CALGARY
COCHRANE
AIRDRIE
CROSSFIELD
STRATHMORE
OKOTOKS
HIGH RIVER
NANTON
CLARESHOLM
GRANUM
FORT MACLEOD
PINCHER CREEK
CARDSTON
VULCAN
GLEICHEN
CANMORE
MUNICIPALITY OF CROWNSNEST PASS



DRUMHELLER
Rosedale
Cambria
East Coulee
Dorothy
Sheerness
YOUNGSTOWN
Chinook
CEREAL
Lanfine
Excel
OYEN
Benton
Sibbald
Sunnynook
Big Stone
Arneson
Acadia Valley
Pollockville
Finnegan
Ferry
Cessford
Makepeace
Gem
Wardlow
DINOSAUR PROV. PARK
Majestic
Buffalo
Bindloss
EMPRESS
BASSANO
ROSEMARY
DUCHESS
Millicent
Patricia
Jenner
Iddesleigh
Princess
Lathom
Southesk
Cassils
BROOKS
Campbell
TILLEY
Kininvie
Bow City
Rainier
Scandia
Alderson
Ralston
Suffield
Bowell
Travers
Enchant
Rolling Hills
Hays
VAUXHALL
Retlaw
REDCLIFF
MEDICINE HAT
Pashley
IRVINE
Walsh
Dunmore
Royal
Seven Persons
Winnifred
Whitla
Turin
Iron Springs
GRASSY LAKE
BURDETT
BOW ISLAND
Purple Springs
Fincastle
TABER
Oranford
BARNWELL
Chin
Tempest
Broxburn
COALDALE
LETHBRIDGE
Stewart
Wilson
Maleb
Elkwater
CYPRESS HILLS PROV. PARK
Judson
Wrentham
Conrad
Skiff
Legend
FOREMOST
Nemiskam
Etzikom
Orion
Manyberries
STIRLING
Welling
RAYMOND
New Dayton
McNab
WARNER
MILK RIVER
Bain
Cressday
Onefour
Aden
COUTTS
Del Bonita
Hilda
Pivot
Schuler
McNeill
8TH BASE LINE
7TH BASE LINE
6TH BASE LINE
5TH BASE LINE
3RD BASE LINE
2ND BASE LINE
1ST BASE LINE
CANADA HIGHWAY
CROWSNEST HWY
BUFFALO TRAIL
THE MIDDLE SAND HILLS
MILK RIVER RIDGE
FOURTH MERIDIAN
SASKATCHEWAN
MONTANA
112°
111°
110°
51°
50°
49°

Irrigation Practice

In order to manage water for maximum yields, one needs to understand the **plant-water-soil relationship**. The amount of water a soil can store is largely determined by the size of the soil particles. To achieve the maximum yield, only about half of the stored moisture in a soil is deemed available for plant use. To force a plant to use the other half of the stored moisture results in slow growth, poorer quality and generally reduced yield. Maintaining the moisture level near the maximum will ensure the highest yield, all other factors being non-limiting.

There is a significant difference in the ability of different soil types to store water. Sandy loam soils will generally store about 100 mm of water per metre of root zone. Total storage of water would then be 100 mm for grain or hay. Good irrigation practice would replace the top 50 mm of water in a sandy loam soil whenever it is used up. In contrast, loam soils have a greater storage capacity; one would replace the top 100 mm of water as it is used up, and for clay soils the top 120 mm. This difference in storage ability is the reason sandy soils must be irrigated more often or require "more rain" than medium or finer textured soils. A particular crop will require a certain amount of water for maximum production, but the number of times it requires irrigation depends on the soil storage capacity, and how often significant rainfall is received.

Not all crops require water at the same time of the year. To manage irrigation, one should understand the different water requirement characteristics of different crops, e.g., cereal crops and alfalfa. Cereals require most of their water during the boot and grain forming stages. In southern Alberta, one could quit irrigating grains after about July 20 without a significant yield loss. Alfalfa, however, will grow vigorously over the whole summer if cut and watered regularly. Therefore, as long as the alfalfa plant is large, the weather is warm and sunny, its moisture use will be high.

Plants also differ in their ability to respond to irrigation after drought. Grain will suffer and not come back to full production after a very dry period. Grasses, however, will usually return to full growth rates after being irrigated properly, only losing the growth that did not occur during the dry period.

Irrigation management is a program to manage water on the farm in which all of the plant-water-soil relatonships involved are considered. If one knows all the factors affecting production, by assessing weather conditions, checking soil moisture conditions and measuring the sun's radiation, one can calculate the present use of water and forecast the expected irrigation time. Thus, the farmer has a very valuable tool to use in managing his complete irrigation farming practice.

A Myth

To the person who has practised dryland farming, irrigation appears to be the whole answer to crop production, and the concept of irrigation is likely to be oversimplified. That a small amount of additional water will do a great deal to increase production is an assumption based on dry farming experience; it does not apply to irrigation. If the benefits of irrigation are to be realized the crop must be supplied with sufficient water over the **entire growing season** in order for the crop not to suffer. Lack of water for even short periods of time will drastically reduce yields. Some specialty crops established under irrigation use soil moisture at a rapid rate and bring on drought conditions quickly unless the soil reservoir is replenished at regular intervals.

Permission to Irrigate

In Alberta, irrigation is most commonly found in the southern part of the province where water is delivered to farms by the established irrigation districts. Each district is run by a board of directors usually assisted by a manager and other technical and administrative staff. In these districts, the farmers pay a yearly **water rate** for each acre **to be irrigated**. In other parts of the province, "private" irrigation schemes may draw water from streams, lakes or rivers, and farmers only pay an initial registration fee for participating in the project, and no annual fee. Permission to divert water from any water source for irrigation purposes outside the organized irrigation districts needs to be obtained from Alberta Environment. Details of what and how to obtain approval can be obtained from any Alberta Agriculture district office or from Alberta Environment.

To Improve Results

A broad range of professional and technical assistance programs is available to help farmers improve their irrigation method and efficiency.

Professional advice and technical assistance are available to help farmers plan or improve on-farm irrigation systems, develop on-farm drainage schemes or prepare agricultural feasibility reports for new irrigation developments. The various irrigation branch offices throughout southern Alberta offer an irrigation management program whereby irrigation farmers are taught the importance of soil-plant-water interactions and how they affect crop production. To make use of any of these programs contact the nearest **irrigation branch office** or ask a **district agriculturist** for a referral.

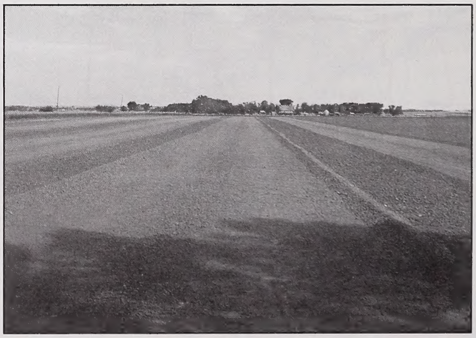


Figure 1 — Border dykes on newly levelled field. Water is applied to the border (the area between the dykes) by either syphon tubes, gated pipe, spikes or breaking of ditch bank.

Figure 2 — Border dykes are being irrigated by diverting water from a concrete lined head ditch with many small syphon tubes. Border dykes are not recommended for downfield slopes above two per cent.

Figure 3 — Installing border dykes on newly levelled and planed field. The dykes usually settle to a height of 120 mm to 150 mm. The dykes could be spaced as much as 30 m apart if land is quite flat and there is sufficient water available to spread over the border.

Figure 4 — With the advent of new equipment, labor requirements for surface irrigation can be reduced significantly through automation.

Figure 5 — Furrows are very efficient when fed by gated pipe. Quite often, only every other furrow will be irrigated, depending on soil type and slope. Germination can be a problem in dry spring.

Figure 6 — Under intense production conditions, where water supplies may be limited, trickle irrigation may be a solution for greenhouse applications. Trickle lines are placed between or on the row in crops such as tomatoes. Emitters are spaced 300 mm to 800 mm apart, depending on soil type and plant spacing.

Figure 7 — A Saskatoon tree is being irrigated by a trickle system. The emitters can be placed on either side or on both sides close to the tree trunk.

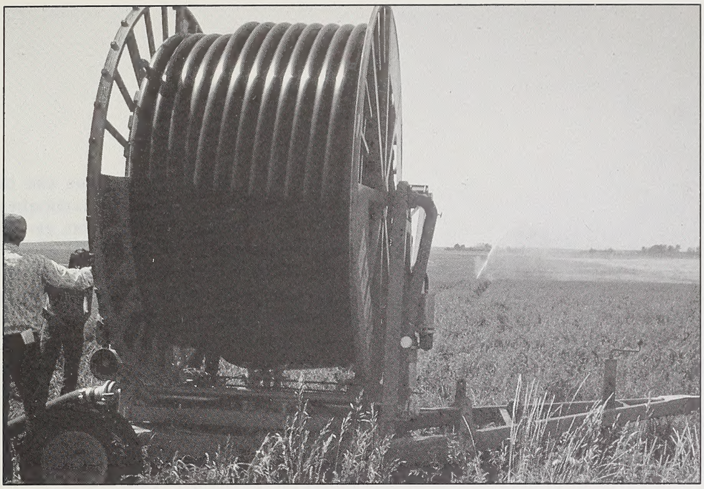


Figure 8 — A reel irrigator is a mobile irrigation system which utilizes a thick walled polyethylene pipe, mounted on a large diameter hose reel. At the end of the pipe is a larger sprinkler mounted on a cart. This system works best where odd shaped fields exist.

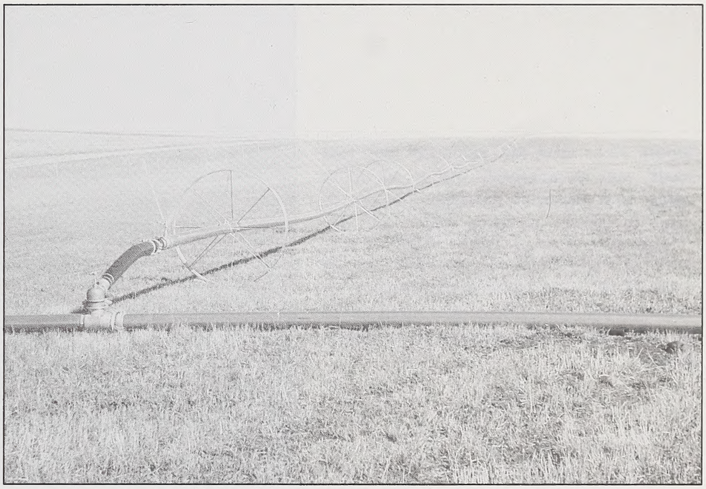


Figure 9 — A side-roll or wheel move sprinkler system takes the back work out of moving pipe by hand. Sprinklers are spaced every 12 m (40 feet) along the lateral line, with hydrants spaced every 18 m (60 feet) along the mainline. The side-roll sprinkler system works best on rectangular fields.

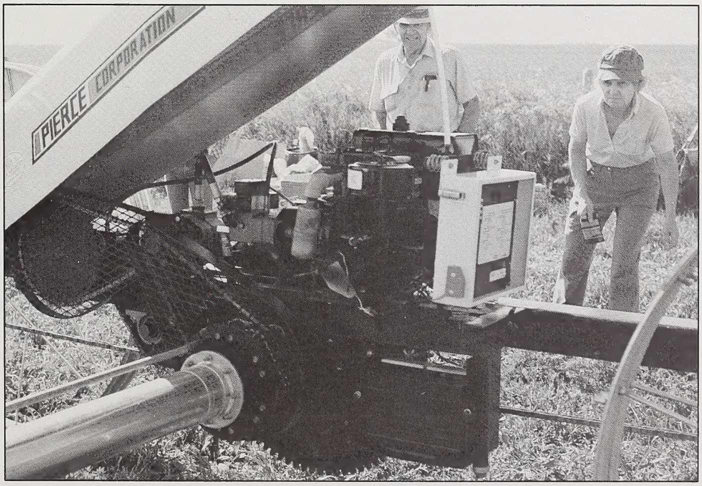


Figure 10 — The mover unit on a side-wheel roll system is powered by a small gasoline engine. To move the side wheel roll system, the following steps need to take place: the hydrant on the main line needs to be closed, water in the lateral line allowed to drain, lateral line disconnected from hydrant, the engine is started and the system is rolled to the next setting.

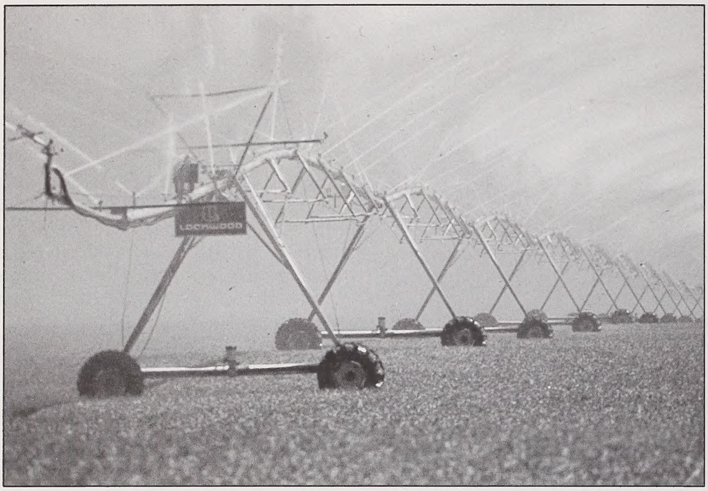


Figure 11 — Labor requirements can be reduced significantly if sprinkling is done by a centre pivot system. Centre pivots can be operated electrically, hydraulically or with water. These systems can operate on relatively rougher terrain, as compared to some of the other irrigation systems.

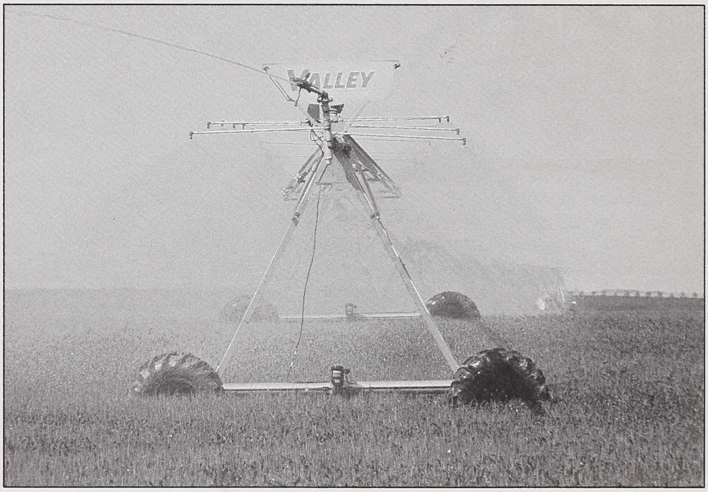


Figure 12 — With the coming of high fuel costs, and consequently higher operating costs, manufacturers have been looking at ways to reduce operating costs. With the introduction of low pressure irrigation systems, operating pressures have been reduced from 75 psi to 25 psi at the pivot point. By reducing operating pressure, a reduction of up to 50 per cent in operating costs may be seen.

Figure 13 — The linear move is a sprinkler system which utilizes the concept of a wheel move system and a centre pivot. The linear move has the same feature as a centre pivot but moves in a straight line, irrigating a rectangular area instead of a circular area.

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